Scientific Research and Development Services

(NAICS 5417)

SIGNIFICANT POINTS

- Professional and related occupations account for 57 percent of all jobs.
- More than 36 percent of workers have a master's, professional, or Ph.D. degree and another third have a bachelor's degree.
- Workers must continually update their knowledge to remain competitive.
- Employment growth will be greatest for computer specialists, scientists, engineers, and technicians.

Nature of the Industry

From carbon nanotubes to vaccines, workers in the scientific research and development services industry create today the technologies that will change the way people live and work in the future. The importance of this industry is demonstrated by the considerable attention paid to it by the press, business associations, politicians, and financial markets. Major discoveries are heralded in both the technical and the popular media, and many studies monitor the pace of research and development. New technologies can quickly revolutionize business and leisure, as the Internet has.

Workers in this industry conduct much but not all of the scientific research and development (R&D) in the economy. Under the North American Industrial Classification System (NAICS), each establishment is categorized by the activity in which it is primarily engaged; an establishment is defined as a single physical location where business is conducted or services performed. This means that much of the R&D conducted by companies in a wide range of industries—such as pharmaceuticals, chemicals, motor vehicles, and aerospace products—is conducted within the scientific research and development services industry, because many companies maintain laboratories and other R&D facilities that are located apart from production plants and other establishments characteristic of these industries. While workers in separate R&D establishments are classified in the scientific research and development services industry, some R&D occurs in establishments that mainly engage in other activities, such as manufacturing or educational services. The latter type of R&D is not included within the scientific research and development services industry.

R&D comprises three types of activities. Basic research is conducted to further scientific knowledge without any direct application. This sort of research typically involves a high level of theory and is very risky; many projects fail to produce conclusive or novel results. Due to the risk and broad applicability of the results, most basic research is funded by government, universities, or nonprofit organizations. Applied research is the bridge between science and business. It is directed toward solving some general problem, but may produce several viable options that all achieve some aspect of the goal. Development, which accounts for more than half of all R&D, according to the National Science Board, then refines the technologies or processes of applied research into immediately usable products. Most development is done by private industry and is generally oriented toward manufacturing. Nearly everything consumers use, from antibiotics to zoom lenses, is a product of basic research, applied research, and development.

This industry includes diverse fields. The most fundamental division of the scientific research and development services industry is that between R&D in the physical, engineering, and life sciences and R&D in the social sciences and humanities. Important areas of research and development in the physical, engineering, and life sciences include the biotechnology; nanotechnology; pharmaceutical; chemical and materials science; electronics; aerospace; and automotive fields. Important fields of research and development in the social sciences and humanities include economics, sociology, anthropology, and psychology.

Biotechnology is among the most active fields of research and attracts about a quarter of all funding from companies in the industry, according to National Science Board data. Work in this field seeks to understand and use the fundamental processes of cellular life to develop more effective medicines, consumer products, and industrial processes. Advances in biotechnology have led to new drugs and vaccines, disease-resistant crops, more efficient enzymatic manufacturing processes, and novel methods of dealing with hazardous materials. Bioinformatics, a branch of biotechnology using information technologies to work with biological data like DNA, is a particularly vibrant new area of work. Much of the interest in biotechnology has derived from the medical applications of its basic and applied research.

Nanotechnology is perhaps even more of an emerging field than biotechnology, and they often overlap in their work on the molecular level, such as with DNA tagging. Nanotechnology is the study of new structures roughly on the same scale as individual atoms, or one millionth of a millimeter. At this size, materials behave differently and can be made into new structures such as quantum dots, which are small devices that behave like artificial atoms and can be used to tag sequences of DNA, make nanoscopic switches for electronics, or produce extremely small lasers for communications equipment. Because basic and applied research comprises the bulk of work, immediate applications of nanotechnology are still relatively few. The National Nanotechnology Initiative coordinates research funding from Federal agencies and facilitates the development of new technologies resulting from this research.

Pharmaceutical R&D is involved in the discovery of new drugs, antibiotics, and vaccines to treat or prevent a wide range of health problems. This field also has benefited greatly from advances in biotechnology, nanotechnology, and chemistry, allowing better models of biochemical processes and more efficient testing. Because a great deal of time is required to develop a new treatment, most companies have several major programs running concurrently, in what is sometimes referred to as the development "pipeline." Because many projects incorporate all aspects of R&D, the pharmaceuticals field tends to do more basic research than do other fields.

Chemical and materials science R&D focuses on the design and creation of new molecules or materials with useful properties. By researching and modeling the properties of molecules under various conditions, scientists in this field can develop new chemical structures that are stable or volatile, rigid or flexible, insulating or conductive. Since chemical R&D is important to many technologies, it can include work on computer chip manufacturing, composite materials development, or pollution reduction through chemical treatment. Chemical R&D also plays a large role in both biotechnology and nanotechnology R&D.

Electronics R&D incorporates a broad range of technologies, including computer hardware, telecommunications, consumer electronics, automated control systems, medical equipment, and electronic sensing. R&D in this field leads to advances that make electronic systems faster, more reliable, more compact, more useful, more powerful, and more accessible. The development of new technologies, such as polymorphic processors for more powerful computers, and the integration of these technologies into new systems account for much of the R&D in this field. Basic research in areas like electromagnetics and photonics also is a significant part of the work.

Aerospace R&D relates to aircraft, spacecraft, missiles, and component parts and systems. More than half of the R&D in aerospace is federally funded, with the Department of Defense and the National Aeronautics and Space Administration supporting most of the work. Civil aerospace R&D now ranges from developing more efficient passenger aircraft to designing private spacecraft to launch satellites or transport humans into space, but most is devoted to making air transportation safer and more efficient.

Automotive R&D creates new vehicles and systems that are more efficient, powerful, and reliable. While automotive R&D may be directed toward the integration of new technologies into vehicles, much research also is done on improving the individual components such as LED headlights or fuel injectors. As electronic technology has advanced, so have automotive designs. The incorporation of computer systems both for monitoring performance and as separate additional features has added a new dimension to R&D in this field. With the demand for more efficient vehicles that provide more power while using less fuel, a good deal of time and many resources are devoted to powertrain and car body R&D.

R&D in the social sciences and humanities is more closely aligned with specific occupations than it is in the physical, engineering, and life sciences. Economic research typically involves monitoring and forecasting economic trends relating to issues such as business cycles, competitiveness of markets, or international trade. Sociological research analyzes the institutions and patterns of social behavior in society, and the results are used mainly by administrators to formulate policies. Anthropological research focuses on the influence of evolution and culture on all aspects of human behavior. Psychological research studies human thought, learning, motivation, and abnormal behavior.

Working Conditions

In 2004, workers in scientific research and development services averaged 37.4 hours per week, compared with 33.7 for workers in all industries. The average for research and development in the physical, engineering, and life sciences was 38.1, while the average for research and development in the social sciences and humanities was only 32.2.

Most workers in this industry work in offices or laboratories; the location and hours of work vary greatly, however, depending on the requirements of each project. Experiments may run at odd hours, require constant observation, or depend on external conditions such as the weather. In some fields, research or testing must be done in harsh environments to ensure the usefulness of the final product in a wide range of environments. Other research, particularly biomedical research, is conducted in hospitals. Workers in product development may spend much time building prototypes in workshops or laboratories, while research design typically takes place in offices.

Although there generally is little risk of injury or illness due to the working conditions, certain fields require working with potentially dangerous materials. In such cases, comprehensive safety procedures are strictly enforced.

Employment

Scientific research and development services provided 548,000 jobs in 2004. Research and development in the physical, engineering, and life sciences accounted for about 88 percent of the jobs; the rest were in research and development in the social sciences and humanities. Although 82 percent of establishments have fewer than 20 workers, 53 percent of employment in the industry is in establishments with more than 250 workers (chart 1).

Although scientific research and development services can be found in many places, the industry is concentrated in a few areas. Just six states—California, New York, Massachusetts, Illinois, New Jersey, and Michigan —account for over half of all R&D. Michigan accounts for the vast majority of R&D in the automotive field.

Over half of the jobs in the industry are in establishments with 250 or more workers. Three-fifths of establishments have fewer than 5 workers.

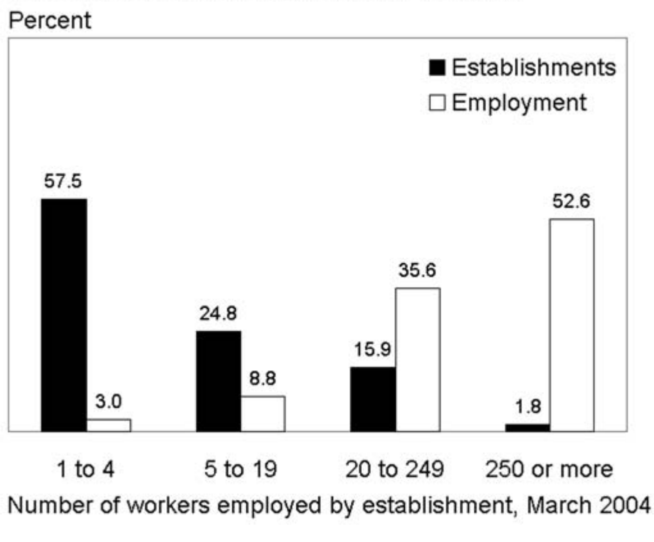

Table 1. Employment of wage and salary workers in scientific research and development services by occupation, 2004 and projected change, 2004-14
(Employment in thousands)

Occupation	Employment, 2004 Number	Employment, 2004 Percent	Percent change, 2004-14
Total, all occupations	548	100.0	11.9
Management, business, and financial occupations	104	19.0	12.8
Top executives	17	3.1	10.1
Marketing and sales managers	5	0.9	15.6
Computer and information systems managers	6	1.0	16.6
Engineering managers	8	1.4	12.9
Natural sciences managers	7	1.3	11.3
Management analysts	6	1.0	10.8
Accountants and auditors	6	1.2	11.1
Professional and related occupations	310	56.6	15.0
Computer and information scientists, research	4	0.6	11.2
Computer programmers	6	1.1	-9.2
Computer software engineers	28	5.1	33.4
Computer systems analysts	6	1.1	22.2
Operations research analysts	2	0.4	10.1
Statisticians	2	0.4	-0.8
Engineers	63	11.5	14.9
Engineering technicians, except drafters	19	3.4	14.0
Agricultural and food scientists	2	0.4	13.6
Biochemists and biophysicists	7	1.2	22.3
Microbiologists	3	0.5	11.5
Medical scientists	18	3.3	22.3
Physicists	5	0.9	5.6
Chemists	11	2.1	6.9
Environmental scientists and geoscientists	3	0.6	14.4
Economists	1	0.2	-3.9
Market and survey researchers	5	0.9	8.4
Sociologists	2	0.3	6.9
Anthropologists	1	0.2	9.3
Life, physical, and social science technicians	37	6.7	10.9
Education, training, and library occupations	11	1.9	11.3
Arts, design, entertainment, sports, and media occupations	10	1.8	10.7
Healthcare practitioners and technical occupations	11	2.0	10.9
Sales and related occupations	12	2.2	8.0
Sales representatives, wholesale and manufacturing	7	1.2	11.4
Office and administrative support occupations	80	14.7	1.3
Supervisors, office and administrative support workers	6	1.0	0.3
Financial clerks	7	1.2	0.7
Information and record clerks	16	2.9	3.9
Secretaries and administrative assistants	30	5.4	5.0
Office clerks, general	11	2.1	-1.4
Production occupations	16	2.9	8.5

Note: May not add to totals due to omission of occupations with small employment

Occupations in the Industry

Professional and related occupations account for over half of the employment in this industry. About 40 percent of jobs are in computer and mathematical sciences, engineering occupations, and life and physical science occupations, and 3 percent of jobs are in social sciences and related occupations (table 1).

Life, physical, and social scientists form the core of the research operations in the industry. *Biological scientists* conduct research to understand biological systems, develop new drugs, and work with genetic material. Most work for pharmaceutical or biotechnology companies; others perform their research in Federal or academic laboratories. *Medical scientists* research the causes of health problems and diseases, and then use this information to develop medical treatments and preventive measures. Their work is similar to that of biological scientists, but with a specific emphasis on disease prevention and treatment. *Chemists and materials scientists* research the nature of chemical systems and reactions, investigate the properties of materials, and develop new products or processes utilizing this knowledge. They perform research used by a broad array of industries to develop new products. Along with *physicists*, chemists and materials scientists conduct basic and applied research on nanotechnology. Social scientists, such as *economists*, *market and survey researchers*, *sociologists*, and *anthropologists*, perform research on human behavior and social interaction. *Science technicians*, sometimes called research assistants, assist scientists in their research and typically specialize in an area of research. They may set up and maintain lab equipment, monitor experiments, record results, or interpret collected data.

Engineers and computer specialists usually are involved in applied research or in development. *Engineers* design, produce, and evaluate solutions to problems, either by creating new products or refining existing ones. They apply the most current research findings to develop more efficient products or processes of manufacture. *Engineering technicians* assist engineers in preparing equipment for experiments, recording and calculating results, or building prototypes. Their work is similar to that of the engineers with whom they work but is more limited in scope. Computer specialists, such as *computer scientists*, *computer programmers*, and *computer software engineers*, develop new computer technologies, programming languages, operating systems, and programs to increase the usefulness of computers. Their work may include integrating advances in computing theory into more efficient processing techniques.

Another 19 percent of employment is in management, business, and financial occupations. *Engineering and natural science managers* accounted for a larger portion of the employment than in most industries. These managers plan, coordinate, and direct the activities of engineers, natural scientists, technicians, and support personnel to conduct research or develop new products. As with engineers and natural scientists, engineering managers tend to be involved in development, while natural science managers tend to be involved in basic research. Both use their technical expertise and business acumen to bridge the gap between goals set by top executives and the incremental work done by engineers and scientists.

Office and administrative support occupations comprise 15 percent of the industry's jobs and primarily handle general business administration and clerical work. *Interviewers, except eligibility and loan*, are particularly prevalent in research and development in the social sciences and humanities, accounting for 8 percent of positions in this part of the industry. They may be involved in soliciting and verifying information from individuals or groups for sociological, psychological, or market survey research, either in person or by phone. In the life sciences, they may collect and verify participant information for medical research.

Since the scientific research and development services industry deals mainly in innovation and design, there are relatively few jobs in production, transportation, sales, or service occupations, which represent less than 6 percent of employment.

Training and Advancement

Scientific research and development services rely heavily on workers with extensive postsecondary education. Those with bachelor's degrees or higher held 68 percent of jobs in the industry, compared with only 30 percent in all industries. The difference is particularly great for those with graduate degrees, who account for 36 percent of workers in scientific research and development services but only 10 percent of workers in all industries.

Science and engineering technicians may enter the industry with a high school diploma, some college, or an associate degree, but some bachelor's degreeholders begin as technicians before advancing to become researchers or pursuing additional education. Technicians usually begin working directly under a scientist, engineer, or more senior technician and advance to working with less supervision. Continuing on-the-job training is important in order to learn to use the newest equipment and methods. Some technicians become supervisors responsible for a laboratory or workshop.

For other science and engineering occupations, a bachelor's degree is generally the minimum level of education, and a master's or Ph.D. degree is typically necessary for senior scientists and engineers. Some fields require a Ph.D. even for entry-level research positions, particularly in the physical and life sciences. A bachelor's degree is sufficient for many types of work in development outside of the life sciences, but a master's degree is much more common—particularly among engineers. Continuing training is necessary for workers to keep pace with current developments in their fields. It may take the form of on-the-job training or formal training, or it may consist of attending conferences or meetings of professional societies. Workers who fail to remain current in their field and related disciplines may face unfavorable job prospects if interest in their specific area declines.

For those with a Ph.D., a period of academic research immediately after obtaining the degree—known as a "postdoc"—is increasingly preferred by employers. These postdocs may last several years with low salaries and little independence, effectively increasing the cost of doctoral degrees in time and forgone income. Once in the industry, workers with doctorates typically begin as researchers, conducting and designing research projects in their field of expertise with a fair degree of autonomy. With their research training and specialized expertise, scientists or engineers with doctoral degrees design, conduct, and analyze experiments or studies. To keep current in their fields, researchers often attend conferences, read specialized journals, and confer with colleagues in industry and academia.

As scientists or engineers gain expertise in a particular field of R&D, they may advance to more senior research positions or become managers. Those who remain in technical positions may undertake more creative work, designing research or developing new technologies at a higher level. Those in science and engineering management usually coordinate work in several disciplines or components of a project. As their careers progress, they manage larger projects and ensure the work aligns with the strategic goals of their organization. Nearly all managers are responsible for some aspect of funding and for meeting deadlines.

Self-employment is uncommon in scientific research and development services because of the high cost of equipment, but opportunities to start small companies do exist. These opportunities are particularly prevalent in rapidly growing fields, partly due to the availability of investment capital. Self-employed workers in scientific R&D typically have advanced degrees and have worked in academia or other research facilities and form companies to develop commercial products resulting from prior basic or applied research.

Outlook

Wage and salary employment in scientific research and development services is projected to increase 12 percent between 2004 and 2014, compared with 14 percent employment growth for the economy as a whole. Biotechnology and nanotechnology will continue to generate employment growth. As the population ages, increased demand for medical and pharmaceutical advances also will lead to growth in these areas. While demand for new R&D is expected to continue to grow across all major fields, this industry will need to digest the recent period of extremely high growth brought about, in large part, by rapid advances in computer and communication systems. Increased efficiency and the increasingly high cost of equipment also will dampen employment growth as less of each dollar spent on R&D is converted into employment.

Some of this slower job growth rate is attributable to the stagnation of the office and administrative support occupations, which are expected to see only modest employment growth as technology leads to greater efficiency in general office functions. Since similarly slow growth is expected in the other major occupational groups within the industry, most new jobs will be created in professional and related occupations.

The highest growth is expected for computer specialists, scientists, and engineers—particularly those in the life and medical sciences. With the aging of the population, the demand for lifesaving new drugs and procedures to cure and prevent disease will drive this demand. Biological scientists, for example, may be employed in biotechnology or pharmaceuticals, both growing areas. Many other scientists and engineers will be employed in defense and security R&D, also a growing field. As information technology continues to be an integral component of R&D, opportunities for computer specialists are expected to grow rapidly, particularly for those with some biological science background working in bioinformatics.

Opportunities for both scientists and engineers are expected to be best for those who have doctoral degrees, which prepare graduates for research. Creativity is crucial, because scientists and engineers engaged in R&D are expected to propose new research or designs. For experienced scientists and engineers, it also is important to remain current and adapt to changes in technologies that may shift interest—and employment—from one area of research to another.

Most R&D programs have long project cycles that continue during economic downturns. However, funding of R&D, particularly by private industry, is closely scrutinized during these periods. Since the Federal Government provides about a quarter of all R&D funding, shifts in policy also could have a marked impact on employment opportunities, particularly in basic research and aerospace.

Earnings

In 2004, nonsupervisory workers in scientific research and development services earned $1,006 per week on average, substantially higher than the $529 average for all industries. The earnings of those engaged in research and development in the physical, engineering, and life sciences differ markedly from the earnings of those in research and development in the social sciences and humanities, with respective averages of $1,041 and $741.

Earnings also varied considerably by occupation, with workers in management and professional occupations earning more. Occupations in the industry with higher earnings typically require higher levels of education and experience. Hourly wages for specific occupations in the industry are shown in table 2.

Table 2. Median hourly earnings of the largest occupations in scientific research and development services, May 2004

Occupation	Scientific research and development services	All industries
General and operations managers	$57.89	$37.22
Computer software engineers, systems software	43.94	38.34
Mechanical engineers	35.85	31.88
Medical scientists, except epidemiologists	31.30	29.48
Chemists	30.03	26.95
Business operations specialists, all other	28.99	25.70
Executive secretaries and administrative assistants	19.62	16.81
Biological technicians	17.56	15.97
Secretaries, except legal, medical, and executive	15.72	12.55
Office clerks, general	13.33	10.95

Sources of Additional Information

For additional information on careers in biotechnology R&D, contact:

- Biotechnology Institute, 1840 Wilson Blvd., Suite 202, Arlington, VA 22201. Internet: **http://www.biotechinstitute.org**
- Biotechnology Industry Organization, 1225 Eye St. NW., Suite 400, Washington, DC 20005. Internet: **http://www.bio.org**

For additional information on careers in nanotechnology R&D, contact:

- National Nanotechnology Coordination Office, 4201 Wilson Blvd., Stafford II Room 405, Arlington, VA 22230. Internet: **http://www.nano.gov**

For additional information on careers in pharmaceutical R&D, contact:

- Pharmaceutical Research and Manufacturers of America, 1100 Fifteenth St. NW., Washington, DC 20005. Internet: **http://www.phrma.org**

For additional information on careers in chemical and materials science R&D, contact:

- American Chemical Society, 1155 Sixteenth St. NW., Washington, DC 20036. Internet: **http://www.chemistry.org**

For additional information on careers in electronics R&D, contact:

- Institute of Electrical and Electronics Engineers–USA, 1828 L St. NW., Suite 1202, Washington, DC 20036. Internet: **http://www.ieeeusa.org**

For additional information on careers in aerospace R&D, contact:

- American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Dr., Suite 500, Reston, VA 20191. Internet: **http://www.aiaa.org**
- Aerospace Industries Association, 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209. Internet: **http://www.aia-aerospace.org**

For additional information on careers in automotive R&D, contact:

- Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096. Internet: **http://www.sae.org**

Information on the following occupations may be found in the 2006-07 edition of the *Occupational Outlook Handbook*.

- Biological scientists
- Chemists and materials scientists
- Economists
- Engineering and natural sciences managers
- Engineering technicians
- Engineers
- Market and survey researchers
- Medical scientists
- Physicists and astronomers
- Science technicians
- Social scientists, other